Amendments to the specification.

[0003] A switched-current power converter, as taught by US Patent No. 6,121,761, "Fast

Transition Power Supply", issued 19 September, 2000, and shown (simplified) in

figure 3 is much faster. A variant (US Patent Application serial number.

10/709,484, "Switched-current Power Converter" filed 8 May, 2004, issued 27

December, 2005 as US Patent No. 6,979,982) having a plurality of switched-

current sources is shown in figure 4. The plurality of current sources can be

generated using one current source and a matrix transformer. The current can

transition from zero to full load and back to zero very quickly, essentially the time

that it takes to close, then open, solid-state switches. The above patent and patent

application are owned by the same entity as the present invention, and they are

incorporated herein by reference.

[0024] Figure 4 shows a prior art switched current power converter 40 (US Patent

Application No. 10/709,484, "Switched-current Power Converter") having a

plurality of [[-]]current sources 41 through 45 each producing an essentially equal

constant current I. The plurality of current sources 41 through 45 can, as an

example, not a limitation, be generated using one current source and a matrix

transformer. The current can transition from zero to full load and back to zero

very quickly, essentially the time that it takes to close, then open, a plurality of

solid-state switching means 46 through 50.

[0027] If the switching means 63 is shown as MOSFETs, the switched current power converter 70 of figure 6 is the result. Note, the voltage on the input will be low or high, respectively, depending upon whether the bottom MOSFET switch 74 or the top MOSFET switch 73 is turned on. An external capacitor ~~64~~ <u>75</u> is shown, to store charge.

[0030] Figure 9 shows that in a switched current converter 90 a constant current I from a source of constant current 94 can be injected into a totem pole cell of a processor 91, and the voltage will be low if the bottom a MOSFET 93 is on, and somewhat over Vcc if a top MOSFET 92 is on. The waveform is shown in figure 10. Assuming a relatively high impedance elsewhere on [[teh]] <u>the</u> data output line, the current will either flow through the top MOSFET 92 to Vcc or it will flow through the bottom MOSFET 93 to the return. If a plurality of constant current sources are connected to a plurality of totem pole cells, the current flowing into Vcc can be any amount from zero to the sum of the current sources, and it can transition as fast as the totem pole cells can change state. Thus a plurality of totem pole cell like circuits can be used in reverse to control the voltage on Vcc just as in the switched power converter 40 of figure 4.

[0032] In addition, the totem pole cell of figure 9 which sinks the current from a constant current source in either state may be a superior data cell, having a larger voltage margin and thus a greater noise immunity. Whereas a top MOSFET with higher resistance degrades performance when it causes a voltage drop from Vcc, it may benefit a current sinking cell, as it would increase the high state voltage. Assuming a wide data bus with a large number of data cells which sink current in

the high state, the contribution to Vcc is twofold. First, when high, it is not a load on Vcc, as in a usual totem pole driver. Second, when high, it is a source of current into Vcc, therefore reducing the current required from other sources, such as a VRM Pod, for processor functions.[[.]]

[0045] If a plurality of totem pole cells is used to control power, there will be a constant circulating current. This means that there is a constant loss in the die, either in the upper MOSFETs as current is directed to Vcc or in the lower MOSFETs as the current is circulated back to the return. Whether the benefits of this method of power control are worth the penalty of this constant loss is a trade off of the system. It may very well be worthwhile, for the following reasons:_First is the advantage of having constant currents in the power distribution bus. With constant currents, there is no di/dt in the power distribution bus, so the loop inductance is no longer a factor. The distribution bus can be quite long and the prime power source can be far away from the processor. With no di/dt, the near field is constant, so there is very little EMI generated by the distribution bus.

[0046] Second is the dynamic response. The currents into the storage capacitor can change from zero to full load and back just as quickly as the MOSFETs can be turned on and turned off, an extremely short time. This has a number of advantages. One is that the capacitors can be much smaller, as the current into the capacitor can be brought into compliance with the load current out of the capacitor very quickly.

[0061] Note that there is an additional "outside switching means" 176 to return on the interposer 153. In some circumstances, it may be undesirable to have a current circulating through the return of the processor continuously even though the current is not needed to sustain Vcc. In such circumstances, the outside switching means 176 may be turned on and the switching means 170 may be turned off. There may be a plurality of outside switching means configured in this manner, and the illustration of only one is to keep the drawing simple. The outside switching means may comprise a totem pole driver as well, with a switching means to Vcc. However it is contemplated that the usual application for an outside switching means would be for modes of operation where the current from the attached constant current source will not be needed and the outside switching means is turned on to reduce circulating current and its attendant power loss within the processor (or other integrated circuit)._With reference to US. Patent No. 6,121,761, "Fast Transition Power Supply", a switched-charge voltage step change capability can be added, as represented by a switched charge switching means 179 and a charge transfer capacitor 180 in figure 15. It is preferred to use external MOSFETs, as the peak current is quite large. Also, the capacitors are very likely external to the processor, and the charge should be switched to the capacitor directly and not put through the processor interconnections. (If the capacitors were entirely within the processor package, that would be a different situation. Then the charge switching should be done there).

[0064] If the total capacitance is known, a change in voltage from a previous measurement and a time between the successive measurements may be used to

calculate a direct quantifier of the current error, so a correct number of switches can be changed quickly to reverse a voltage drift. Further, in anticipation of an operation, and with knowledge of the estimated current required for the operation, the processor can command a change of current at the start of the operation and again at the end. If the estimate is a little off, the error may be corrected by the error algorithm, but this will eliminate the chance of large current mismatches, improving voltage regulation and reducing the size of the capacitor needed.